



Advanced Learning Technologies

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A

Advanced Learning Technologies

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Synonyms

Artificial intelligence in education; Intelligent tutoring
systems; Learning environments; Technology enhanced
learning

Definition

Advanced Learning Technologies (ALTs) are artifacts
(*technologies*) that enable, support, or enhance human
learning, emerging from the most recent *advances* avail-
able in both areas. There are nowadays two real challenges
to be faced when trying to outline in detail this definition
of ALTs as a meaningful, full-fledged state of the art of the
key concepts for future use, not just an historical overview
of socio-technical approaches. The main technical chal-
lenge is due to the unprecedented speed of innovation
that we notice in Information and Communication Tech-
nologies: ICTs; in particular: the Web. The educational
challenge is a consequence of the technical one.
An account of educational uses of technologies has to
consider the impact of ICT innovation onto unexpected
changes in human practices in any domain, modifying
substantially the classical human learning cycle that since
the nineteenth century was mainly considered to be
managed within formal teaching institutions such as the
schools. Therefore, our interpretation of *advanced* will be
in the sense of *dynamic*, *experimental*, *to be implemented*
and evaluated in order to limit the risk that what we
describe today as advanced will be considered obsolete in
a few months. This vision of ALTs, however, does not
underestimate the interest for a reasoned analysis of past
experiences. On the one side this analysis will guide us to
avoid well-known pitfalls, on the other it will teach us
lessons not only about how to exploit the potential learn-
ing effects of *current* advanced technologies – the

applicative approach – but also how to envision, elicit, 40
estimate, evaluate the potential promising effects of *new* 41
technologies and settings to be studied and developed 42
within human learning scenarios – the experimental 43
approach – the last, enabling scientific progress both in 44
Informatics and in Psychology of human learning. 45

Theoretical Background

Advanced Learning Technologies may be described and 46
classified according to different criteria, such as their his- 47
torical development (from the PLATO – TICCIT invest- 48
ments in the 1960s in the US, to current wikis, semantic 49
web and social networks) or their links with disciplinary 50
works (Informatics, Psychology, Pedagogy, etc.). Each and 51
all these classifications are widely available already (► ITS: 52
Intelligent Tutoring Systems or ► AI in Ed: Artificial Intel- 53
ligence in Education or ► IEEE ICALT: International Con- 54
ference on Advanced Learning Technologies). What seems 55
to us interesting here is to present a couple of *new* criteria 56
that may offer a frame of reference for the years to come. 57
Classification criteria should be now different because we 58
are facing a totally different world that is globally 59
connected through the Web where the role of ICTs 60
becomes primary for science, education, and any socio- 61
economic domain. In this sense, most of the remarks in 62
this article are intertwined with the ones in the Web 63
Science one. The core observation is that on the current 64
Web, humans are both consumers and producers of Infor- 65
mation and of Services, i.e., they have a bidirectional 66
access to the Web. Differently said, the modern Web con- 67
sists of some billions of machines *and* of connected peo- 68
ple. In this context, previous definitions are challenged; 69
for instance the classical distinction between technologies 70
and humans (artificial and human autonomous agents) 71
needs to be revisited. 72

Reflecting on each word on turn: let us start with 74
Technologies. It is to be debated if current Information 75
and Communication Technologies (ICTs) are just tech- 76
nologies in the traditional term (artificial tools, artifacts 77
that facilitate the human for the achievement of his/her 78
goals) or rather, represent the modeling substrate of cur- 79
rent and future reality. For instance: social networks are 80
just tools or – by including the millions of humans 81

connected – are they a new natural phenomenon, as it is envisaged in the Web Science view? In the latter hypothesis: where is the equilibrium between a vision such that humans exploit technologies for their superior needs and the dual one: technologies influence humans in their behavior, an issue that may be classified under the topic of coadaptation? Are these technologies applications of previously defined principles and design rules or rather do they emerge as the evolution of a kind of natural selection process among thousands of options available?

In this reflection, the contributions of Eileen Scanlon and Tim O'Shea (2007) and Marc Eisenstadt (2007) are a splendid synthesis of the last 40 years of research, developments, and practical implementations; successes and failures, directions to go and pitfalls to avoid. The main conclusions are that *we now have new topologies for learning which have no direct analogues in past educational practice* (Scanlon and O'Shea 2007) . . . and *the essence of the problem is that new-tech disguising old ideas is almost certainly doomed to failure. Learning Management Systems and Learning Objects, for example, despite the noble intentions of many protagonists, can in fact conceal neobehaviourist drill-and-practice thinking* (Eisenstadt 2007).

The subsequent word to be examined is *advanced*. This is rather self-explaining; however, the meaning of the word concerns more likely the exploratory nature of the infrastructures, tools, and practical implementations that one wishes to consider for enabling, supporting, or enhancing human learning. The issue is not so superficial, knowing that often people do not consider that the introduction of technologies in human life, particularly in Education or Learning, implies a profound modification of the human behavior. In principle, radical changes are regarded with suspect by the key actors. In our case, students (learners) are usually ready to accept, while teachers and administrators resist to the introduction of changes as most professionals often do with respect to innovation (other historical examples being technologies for health or for the legal professions). Therefore, *advanced* suggests a life cycle of innovation that cares for an experimental part: similar to a spiral (software development) approach based on trial and error as opposed to the waterfall one, in order to *motivate and convince* the actors of their own interest to adopt changes in their practice. No major change in the work practice will ever occur if it is not preceded by an experimentation that puts the actors and their motivation and awareness at the center of the implementation itself. Some authors even reverse the argumentation by proposing to exploit the proactivity of humans in open participatory learning infrastructures – *serendipitous mashups*

foster creative integration (Eisenstadt 2007). Anyway, the classical concepts of ICT products optimizing the acquisition of knowledge and skills by interactive training are challenged by more modern concepts of peer-to-peer services adapting to the partner's needs and collaborating in social networks in order to facilitate learning. More often as before, those modern socio-technical scenarios enable human learning that otherwise would be impossible to conceive, so that the administrator's right question becomes more *what would happen if we do not use technologies for learning* as the traditional question: *why should we use them?*

Thirdly, we are interested in *learning technologies* in the sense of human learning. However, we know very little about human learning. The relation teaching-learning (effects of teaching) is not always clear (see, e.g., *the no significant difference phenomenon* Web site: <http://www.nosignificantdifference.org/>). We are facing a kind of dichotomy between a natural process (human learning) and the practice supposed to facilitate it (teaching). The opposition is similar to the one of biology versus medicine: practicing medicine is not worth unless the patient is healed. Similarly, the only interest of teaching is in its effects: that learners indeed learn. Medicine is an art while biology is a natural science; we will never better our practices in medicine unless we better understand the underlying biological phenomena concerned. For those reasons, it is important to admit that technologies for teaching do not necessarily imply better or different learning. A vision of human learning may have a substantial influence on the priorities to attribute to the development of technologies for learning, the most radical difference being the one between behaviorism, constructivism and social constructivism which are treated extensively elsewhere in this encyclopedia.

Important Scientific Research and Open Questions

The most important scientific research question concerns which discipline profits from the success of the interdisciplinary projects in ALTs. These profit from disciplinary competences of humans, and may produce advances in each discipline but in quite different proportions according to the choices made in the goals, plans etc., adopted for the research process. In making progress in ALT, does one produce advances in understanding learning, thus improving as a side-effect teaching practices, or rather the technologies experimentally developed in educational or learning scenarios are significant for progress in Informatics? One of the most interesting paradigm shifts in current Web Technologies and Web Science is

183 that new usage-centered business processes do require to
184 introduce interoperability among machines and people
185 but reuse old technologies. Another is that social software
186 success is hardly to be forecasted and may not be stable,
187 will rather be dynamic, evolving, and volatile. So it is the
188 case for the learning effect of informal learning situations
189 such as those offered by the Web. The acceptance is also
190 variable with the age: digital natives behave differently as
191 digital immigrants independently from their role of stu-
192 dents, teachers, or administrators. Within this totally new
193 framework, the real open question concerns what are the
194 established principles that we may assume as valid and
195 how to progress.

196 For instance, in the Bioinformatics of genome it is well
197 known that the main effect is a progress in understanding
198 the genome; minor effects though exists in the availability
199 of efficient algorithms for generic purposes (advances in
200 Informatics). The opposite case considers the business
201 domain (human learning in our case) as a *scenario* for
202 the elicitation of new ideas (not as an application
203 domain): an example being the seminal work done by
204 Alan Kay around the Dynabook as well as Smalltalk in
205 the early 1970s. Fundamental advances in Informatics
206 research (the personal computer, the first real object ori-
207 ented programming language, the window interface, the
208 integrated environment including the language and the
209 interface, etc.) emerged from observations about the needs
210 of children (the dynamic book; the small talk for small
211 children) with an enormous impact in the 40 following
212 years. Similarly, the PLATO system conceived in the 1960s
213 by Don Bitzer and Paul Tenczar for military and educa-
214 tional purposes was a precursor of many currently
215 used generic interactive technologies: the PLASMA flat
216 512×512 dot graphic display with images superimposed
217 projected from a microfiche of color slides; an operating
218 system with a kind of virtualization of student's variables,
219 enabling in the 1970s the remote access of up to 1,000
220 simultaneous users, the TERM-TALK option for chatting,
221 the interactive TUTOR programming language that later
222 became TENCORE for PCs, etc. On the opposite side,
223 TICCIT was an early example of pure exploitation of the
224 television for distance education with no real ambitions of
225 advances in technologies.

226 In the case of ALTs, the most important advances
227 concerned with modeling human learning have been
228 obtained as a consequence of the need to tune (or adapt)
229 interactions to individual learners. As Artificial Intelli-
230 gence has demonstrated, modeling complex natural phe-
231 nomena implies understanding them better. In the case of
232 learner modeling, it means understanding better human
233 learning. The domain of learner modeling, opened by the

foundational work of John Self (1974) has been at the core
of years of quite profound research of generic impact for
human-computer interaction, where models have
represented human competence, human skills and, more
recently, human emotions and personality traits. Adapt-
able interfaces are now among the top priorities of any
modern ICT application.

However, the fundamental question on ALTs still
remains, after more than 50 years of research and practice.
The question is if ALTs are concerned with a more efficient
production of teaching material by using technologies, as
it was the case for the CAI (Computer-Assisted Instruc-
tion or its synonyms) that basically attempt to mimic the
schoolteacher in transmitting content and examining the
acquisition of the subject matter, or rather are called for
stimulating learning by dialogue and interaction in any
area (learning environments), such as it is the case for
(serious) games, social networks, communities where
learning may occur as a side effect of social interaction.
In order to have once more a direct answer, one may refer
to the arguments of one of the pioneers: John Seely Brown.
Related to this question, the distinction is sometimes
made between formal and informal learning. In the first
case, today's focus is ontologies (the intensional represen-
tation of concepts and relations for reasoning, problem
solving, and search), instructional design and experiments
on the learning effects due to teaching strategies. In the
second case the issues are interaction design, dialogue
management and the evaluation of the success by other
parameters such as motivation, implication in social net-
works, and professional impact of the actors. It is certain
that both approaches are synergic to one another.

While Artificial Intelligence may pervade each of the
approaches, it does it in very different ways. In order to
understand how pioneers paved the way for radical
changes in the research and practice on ALTs, we refer to
the inspiring paper of Jaime Carbonell (1970): the notion
of mixed initiative dialogue has introduced a shift in the
conception of classical, previous educational software
(such as the one produced on PLATO) by requiring the
automated tutor to understand the learner's question,
needs, and statement. While in the beginning this was
supposed to require just some natural language software
able to recognize *WH- questions*, later the approach
opened the research agenda on user models and, in gen-
eral, on dialogues including models of the pragmatics of
conversations such as those typical of modern Agent
Communication Languages (performatives, speech acts).

As a conclusion, ALTs are at the core of questions and
answers that have challenged informaticians since the
1960s. ALTs have historically been prototypical for most

285 innovations in interaction models and technologies as well
286 as, nowadays, in interactive, multi-centric, heterogeneous,
287 asynchronously communicating service-oriented business
288 (learning) processes (Cerri et al. 2005; Ritrovato et al.
289 2005). In its essence, the question concerns how to *design*
290 *interactions* suitable to have effects on a human partner in
291 conversations where the meaning of design is far from the
292 rigid definition of classical workflow and more in the sense
293 of exploiting open interactions for enhancing learning.
294 This scientific question fits well with very modern issues
295 (service-oriented computing: semantics, processes,
296 agents). A service is different from a product in the sense
297 that it is produced on the fly when required by the con-
298 sumer (dynamic) and its effectiveness is measured by the
299 consumer's satisfaction, not just by its intrinsic perfor-
300 mances. This recent paradigm shift in Informatics fits
301 better with the above mentioned concepts of conversa-
302 tions among autonomous agents (such as teachers,
303 learners, or other actors in the community of practice)
304 where the dimension of heterogeneity of knowledge, com-
305 petence, skills and motivation, the distribution of
306 resources and interests, the asynchronous communication
307 channels and patterns, the coexistence of artificial and
308 human agents in the collaborative efforts, the ubiquity of
309 bidirectional access worldwide ought to be considered
310 components of a Web Science scenario where learning
311 occurs everywhere at any time rather than classical ICT
312 products in a traditional classroom equipped with some
313 computers.

Cross-References

► Interactive Learning Services	314
► Learning as a Side Effect	316
► Serious Games	317
► Social Networks	318
► Web Science	319

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